

TABLE OF CONTENTS

301	SYMBOLS.....	5
1.0	Where to Use Symbols.....	5
2.0	Size of Symbols	5
3.0	Symbol Types	5
4.0	Symbol Library	5
302	CIVIL DRAWINGS	5
1.0	Drawing Design Preparation.....	5
2.0	Grading and Site Plans.....	6
3.0	Landscaping Plans	7
4.0	Utility Plans	8
5.0	Road Plans	8
6.0	Road Profiles.....	9
7.0	Road, Parking Lot, & Site Grading Cross Sections (looking up-station).....	9
8.0	Storm Drain Plans	9
9.0	Storm Drain (profile)	10
10.0	Sanitary Sewer Plans	10
11.0	Sanitary Sewer Profiles.....	11
12.0	Water Supply and Distribution	11
13.0	Radioactive Liquid Waste, Caustic, Acid and Chemical Plans, and Profiles	12
14.0	Civil Symbols.....	12
303	STRUCTURAL DRAWINGS.....	12
1.0	Designation of Column Lines	12
2.0	Structural Steel Framing Drawings.....	12
3.0	Structural Steel Shapes	13
4.0	Reinforced Concrete	13
5.0	Structural Drawings	13
6.0	Reinforced Concrete Drawings.....	14
7.0	Structural Steel Drawings	14

continued on next page

TABLE OF CONTENTS (continued)

304	ARCHITECTURAL DRAWINGS	15
1.0	Drawing Design Preparation	15
2.0	Life Safety Plans	15
3.0	Demolition Plans	16
4.0	Foundation Plans	16
5.0	Floor Plans	17
6.0	Reflected Ceiling Plans	18
7.0	Floor Finish Plans	19
8.0	Building Elevations	19
9.0	Building Sections	20
10.0	Enlarged Details and Plans	21
11.0	Roof Plans (Construction)	21
12.0	Floor Plans of Record (FPR)	22
13.0	Roof Plan of Record (RPRs)	29
14.0	Miscellany	30
15.0	Evacuation Route Diagram (ERD)	31
16.0	Architectural Symbols	32
305	MECHANICAL DRAWINGS	32
1.0	Mechanical Drawings	32
2.0	Process Flow Diagrams (PFDs) & Piping & Instrument Diagrams (P&IDs)	33
3.0	Mechanical Equipment List	35
4.0	Mechanical Symbols	36
306	ELECTRICAL DRAWINGS	36
1.0	General	36
2.0	One-Line Diagrams	36
3.0	Electrical Equipment Plans	37
4.0	Wiring Diagrams	38
5.0	Electrical Schematics	38
6.0	Electrical Schedules	38
7.0	Lightning Protection System (LPS)	38
307	PLUMBING	39
1.0	General	39
2.0	Plumbing Systems	39
3.0	Isometrics and Schematics	39

continued on next page

TABLE OF CONTENTS (continued)

308	FIRE PROTECTION DRAWINGS.....	40
1.0	Drawing Design Preparation.....	40
2.0	Building Architectural and Structural Features	41
3.0	Emergency Lighting.....	41
4.0	Fire Alarm Systems.....	42
5.0	Special Extinguishing Systems	42
6.0	Sprinkler Systems	43
7.0	Water Supplies	44
8.0	Other Systems	44
9.0	Attachments	45
	Attachment 1: Historically Used Drawing Numbers.....	45
	Attachment 2: Existing Facility Modification Process Guidance.....	45
10.0	Appendices.....	45
	Appendix A: General – Plot Limits, Txt Conversions, Line Types Chart.....	45
	Appendix B: General Symbols Chart	45
	Appendix C: Civil Symbols Chart	45
	Appendix D 1-3: Fire Protection Symbols Chart.....	45
	Appendix E 1-3: Mechanical Symbols Chart	45
	Appendix F 1-3: Electrical Symbols Chart.....	45
	Appendix G 1-4: P&ID and PFD Symbols Chart.....	45
	Appendix H: Title Blocks and Title Sheet Informational Chart.....	45
	Appendix I: Architectural Symbols Chart	45
	Appendix J: Plumbing Symbols Chart.....	45
	Appendix K: Welding Symbols Chart	45

RECORDS OF REVISION

<u>Rev.</u>	<u>Date</u>	<u>Description</u>	<u>POC</u>	<u>OIC</u>
0	06/29/99	Document rewritten and reformatted to support LIR 220-03-01, Facility Engineering Manual. This chapter supersedes LANL Facility Engineering Standards Drafting Manual, Vol. 2, Rev. 7, dated 4/17/98.	Danny Nguyen, <i>PM-2</i>	Dennis McLain, <i>FWO-FE</i>
1	10/29/01	Symbols - generated & on-line; Civil – expanded; Structural – slight modification; Architectural, Mechanical, Electrical - expanded greatly; Mechanical and Electrical - also refer to LEM new examples.	Richard Trout, <i>FWO-SEM</i>	Mitch S. Harris, <i>FWO-SEM</i>
2	07/15/02	Add new subsections (7.0 & 8.0) on Record Floor Plans. Correct Layering Table. Minor editorial changes as indicated by revision bars.	Richard Trout, <i>FWO-SEM</i>	Kurt Beckman, <i>FWO-SEM</i>
3	09/16/04	Added requirements for evacuation route diagrams, various plans: life safety, demolition, reflective ceiling, floor and roof plans of record; lightning protection drawings, plumbing and fire drawings. Addition of Attachment 1. Change from LEM to ESM (Engineering Standards Manual). Other editorial changes as noted by revision bars.	Richard Trout, <i>FWO-DECS</i>	Gurinder Grewal, <i>FWO-DO</i>
3 change 1	09/26/05	Minor change. Corrected grid lines on Fig. 303-1 and organizational name changes.	Richard A. Trout, <i>ENG-DECS</i>	Gurinder Grewal, <i>ENG-CE</i>

PLEASE CONTACT THE RESPONSIBLE ENGINEERING STANDARDS POC AND COMMITTEE
for upkeep, interpretations, and variance issues

LDM	Drafting Manual POC
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301 SYMBOLS

1.0 WHERE TO USE SYMBOLS

Use standard symbols on all drawings, whenever possible. *Guidance: The use of symbols can reduce the drawing time and clarify the drawings by the elimination of unnecessary details.*

2.0 SIZE OF SYMBOLS

Guidance: Symbol sizes can vary according to their use on drawings made “to scale” or “not to scale.” The size of symbols on drawings “not to scale” is dependent upon the complexity and aesthetics of the drawings.

3.0 SYMBOL TYPES

The LANL Drafting Symbols [Library](#) is not intended to be a complete listing of all possible symbols required for a project. Symbols may be created if not available in the LANL Drafting Symbols Library or in industry standard symbols. The Library’s symbols can be revised via controlled revisions by the Drafting Manual POC with Standards Manager approval (but without a Manual revision or Engineering Standards Board approval).

Identify symbols generated that are not in the LANL Drafting Symbols Library on the discipline legend with a (NS) “non standard” located to the right of the symbol description.

4.0 SYMBOL LIBRARY

- A. Symbols generated in the LANL symbol library are drawn 1:1. Insert accordingly, consistently, and to the proper size in relation to the drawing.
- B. Do not explode symbols with text to meet text requirement in Section 213.
- C. Symbols generated are from various National Standards. When discrepancies in symbols occur in the National Standards, only one was selected to be placed in the library.
- D. Symbols are revised on a regular basis. LANL will only indicate symbol revisions by notating the new revision number and date on the affected appendix, not on each individual symbol.

302 CIVIL DRAWINGS

1.0 DRAWING DESIGN PREPARATION

- A. Draw to scale and show north arrow symbol. Show dimensions including elevations in feet and decimals of a foot.
- B. Include in the site plan existing planimetric features such as buildings, roads, walks, parking areas, large trees, underground and overhead utilities, valve boxes, water meters, fire hydrants, pressure reducing valves, backflow preventers, thrust blocks, valve pits, and other features pertinent to the specific project.

- C. Refer to the mechanical drawings for lift stations, sumps, valves, etc. Include in the civil drawings site utilities outside building perimeters. *Electrical/communications site plans may be separated from the utilities plans providing they are carefully coordinated.*
- D. Prepare the site plan from a current survey tied to known survey markers located in accordance with the New Mexico State Plan Coordinate System (NMSPC), central zone, North American Datum 1983 (NAD), and mean sea level elevations. Provide appropriate drawing scale to clearly identify the project construction limits, planimetric features, and proposed improvements. Provide additional sheets with match lines if necessary. Include in the plan information necessary for layout of all elements of the new project.
- E. Include in the plans, or separate drawing, existing and new features including final contours clearly annotated at appropriate intervals; spot elevations; finish grades for drainage; site improvements; plan and profile of roads, walks, and drainage structures; test hole boring locations; and borehole data (if available).
- F. Include in the landscape and/or terrain management plan, a list of plant materials, fences, signs, erosion control measures, irrigation systems, berms, screens, gravel areas, lights, and other landscape features, amenities, and structures.
- G. Provide plan and profile drawing sheets for existing and new utility systems in the area surrounding the project. Prepare a plan and profile for new underground utility systems showing invert elevations, pipe slopes, and cover depths over the systems shown. *Provide scale of 1 inch equals 20 feet. Adjustments to the scale are allowed to improve clarity or to avoid excessive sheets and match lines.*
- H. Prepare design profiles for: sanitary sewers, storm drains, steam and condensate lines, roadways, drainage channels, and other facilities as required.
- I. Prepare earthwork cross sections for: roadways, parking lots and site grading.
- J. Prepare profiles or cross-sections for locations where new underground utility runs cross other existing utilities. Show new utility lines as continuous in profile with break lines provided to show changes in direction. Stationing for gravity sewers, storm drains and drainage channels shall progress up gradient where possible. Progress stationing from left to right on the drawing, preferably with the north arrow pointing up or to the right side of the drawing.
- K. Reproduce the soil boring logs and required notes on the drawings. Show borehole locations in plan view with accurate state plane coordinates, surface elevations and stratigraphic depth information.

2.0 GRADING AND SITE PLANS

Include the following:

- A. Existing utilities including type, size, and locations from field survey information.
- B. Existing permanent structures, roadways, fences, walks, retaining walls, and any additional planimetric features to clearly identify the work area.

- C. Manhole invert and rim elevations for existing sewers, storm drains, electrical manholes, and all other manhole types.
- D. New construction, items to be removed, and limits of work. Provide a site removal plan if appropriate.
- E. Clearing and grubbing areas.
- F. Existing contours, finished contours, and critical (existing and finish) spot elevations for proposed grading and paving improvements.
- G. Stationing, NMSPC coordinates or bearings and distances for location of facilities.
- H. Boring test holes and logs where applicable.
- I. Cross sections where major grading work is involved.
- J. Storm Water Pollution Prevention Plan (SWPPP) with proposed erosion control measures.
- K. Match lines of adjacent drawings.
- L. Fencing (standard or security).
- M. Pedestrian/vehicle circulation patterns, curb and gutter, parking layout, striping, permanent signing, and sidewalks.
- N. Location map.
- O. Traffic control plan including temporary construction signing and signals in accordance with the Manual of Uniform Traffic Control Devices.
- P. Stockpile and borrow areas.
- Q. Temporary laydown areas for the contractor's equipment.
- R. Security fence locations for "Bubbled Out" (space left blank for security purposes) areas.

3.0 LANDSCAPING PLANS

Include the following:

- A. Planting/irrigation.
- B. Recreational layouts.
- C. Visual screening.
- D. Plant species and size.

4.0 UTILITY PLANS

Include the following:

- A. Location of existing structures and facilities (no contours required).
- B. Location of all utilities and describe them as to size, type material, slope and indicate fittings.
- C. Proposed points of intersections of all utilities crossings for interference.
- D. Depth of cover for utilities.
- E. Details.
- F. Rim and invert elevations on sanitary sewer and storm drainage.

5.0 ROAD PLANS

Include the following:

- A. Geometric plan and profile, pavement markings, surfacing, thickness, cross section, and traffic control devices.
- B. Operational plan for vehicular circulation is required showing turnaround movements, ingress and egress.
- C. Centerline location, coordinates, or bearing and distances.
- D. Stationing.
- E. Curve data (show delta (D), radius (R), tangent (T), length (L), chord bearing (CH), point of curvature (PC), point of intersections (PI), and point of tangency (PT)).
- F. PC and PT stationing.
- G. PI coordinates.
- H. Typical roadway sections with pavement type and thickness, base and sub-grade materials, cross slopes, and taper details.
- I. Drainage culverts, size and type, ditches, and hillside interceptor benches and slopes. Include flowline elevations at culverts and slopes.
- J. Utility crossings.
- K. Horizontal alignment design parameters.

6.0 ROAD PROFILES

Include the following:

- A. Ground line (existing grade at centerline road).
- B. Finished grade (top of finished surface at centerline).
- C. Left and right curb profiles (if required).
- D. Longitudinal grades in percentages.
- E. Elevations at station intervals and vertical curves including: vertical point of curvature (VPC), vertical point of intersection (VPI), and vertical point of tangency (VPT).
- F. Elevations along vertical curve and tangents (if required).
- G. Vertical alignment design parameters.
- H. Drainage culverts & utility crossings.

7.0 ROAD, PARKING LOT, & SITE GRADING CROSS SECTIONS (LOOKING UP-STATION)

Include the following:

- A. Stationing, scales, and earthwork requirements.
- B. Centerline and/or baseline location.
- C. Existing ground line (phantom line type).
- D. Finished grade surface and bottom of base course (continuous linetype).
- E. Annotate cut and fill slopes.
- F. Ditch sections and structural features such as drop inlets, culverts, etc.

8.0 STORM DRAIN PLANS

Include the following:

- A. Existing underground structures including size, type, and location. (To be relocated or removed.)
- B. Existing storm drains, culverts, inlets, and outfall structures.
- C. Existing utilities.
- D. New storm drain location (including coordinates, distances, and bearings), stationing, curve data (show D, R, T, L, PC, PI and PT), manholes, transitions, and junction structures.

- E. Catch basin locations. (Tie to curb returns or centerline road stationing/offset), type, size, invert elevations).
- F. Pipe length, size, type, pipe slope, and end inverts.
- G. Utilities crossings - water, sewer, gas, steam, electric, telephone, etc.
- H. Unique trenching, shoring, benching, and/or backfill requirements.

9.0 STORM DRAIN (PROFILE)

Include the following:

- A. Ground line (existing grade at centerline storm drain).
- B. Street names, building designations, and existing structures.
- C. Existing underground utilities including sizes, types, interferences, and elevations.
- D. Centerline stationing, match lines, manholes, structures, design slopes, flow rates, and grade changes.
- E. Storm drain slope (ft/ft), invert elevations, length, size, type of pipe, centerline stationing, direction of connecting pipe inlets, and transition structures.
- F. Parallel existing storm drains.
- G. Parallel existing utilities.
- H. Concrete or other encasement for utility crossings.
- I. Details of crossings with existing utilities.

10.0 SANITARY SEWER PLANS

Include the following:

- A. Existing underground utilities, size, type, and location.
- B. Proposed sewer centerline geometry (coordinates, distances, and bearings), stationing, curve data (show D, R, T, L, PL, PI and PT), manholes (type and all callouts from standard drawings), and sizes.
- C. Encasement of sewer.
- D. Curbs, driveways, and sidewalks to be removed and replaced.
- E. Fire hydrants, valves, meters or other utility appurtenances to be relocated.

11.0 SANITARY SEWER PROFILES

Include the following:

- A. Existing ground line and proposed cover along center line of sewer.
- B. Substructures and/or utilities (parallel or crossing) including size, type, rim and invert elevations (excavated and checked, if required).
- C. Centerline stationing, match lines, manholes, structures, design slopes, flow capacity, and grade changes.
- D. Sewer profile slope and elevations, (ft/ft) and (ft), length, type, and diameter of pipe, centerline stationing, and direction of connecting inlets or Y branches.
- E. Parallel existing storm drains.
- F. Encasement for sewers.
- G. Details of crossings with existing utilities.

12.0 WATER SUPPLY AND DISTRIBUTION

Include the following:

- A. Location of all structures and facilities.
- B. Location, size and type of domestic water lines, valves, valve pits, meters, etc.
- C. Location, size and type of fire water lines, hydrants, post indicator valves, PRV's, storage tanks, valves, valve boxes, meters, and pits.
- D. Coordinates at all angle points of distribution lines.
- E. Bearing and distance between PT's.
- F. Show existing utilities and structures along alignment.
- G. Show section cut including invert elevations at all utility crossings.
- H. Horizontal/vertical alignment design parameters.
- I. Typical trench sections, bedding, and backfill requirements.
- J. Restrained fittings and/or thrust block locations and calculations.
- K. Horizontal geometry including curve data, if required, D, R, T, L, PC, PI and PT.

13.0 RADIOACTIVE LIQUID WASTE, CAUSTIC, ACID AND CHEMICAL PLANS, AND PROFILES

Include the following:

- A. Existing ground line and proposed cover over the piping.
- B. Substructures and/or utilities (parallel or crossing) including size, type, rim and invert elevations (excavated and checked, if required).
- C. Piping profile slope and elevations, (ft/ft) and (ft), length and type of pipe, size, station size, and direction of connecting inlets or Y branches.
- D. Monitoring system instrument and control
- E. Location of control valves, type, model number, and access requirements.
- F. Centerline stationing, match lines, manholes, structures, design slopes, flow capacity, and grade changes.
- G. Encasement for piping.
- H. Details of crossings with existing utilities.

14.0 CIVIL SYMBOLS

See Appendix C of this manual.

303 STRUCTURAL DRAWINGS

1.0 DESIGNATION OF COLUMN LINES

On the Plot Plan and Foundation Drawings, locate structures by coordinates or orthogonal offsets. The location of the base point coordinate shall be the intersection of the column lines in the northeast corner of the structure, where practical. The column line bearing and offset distance, or coordinate of an alternate column line intersection point shall be designated, see section 201.5.

2.0 STRUCTURAL STEEL FRAMING DRAWINGS

Framing Plans and Framing Elevations are schematic drawings. Show the centerlines of steel framing members as solid heavy lines stopping short of the member they frame into. Only show partial outlines of webs, flanges, and legs of members when necessary for clarity.

Example:

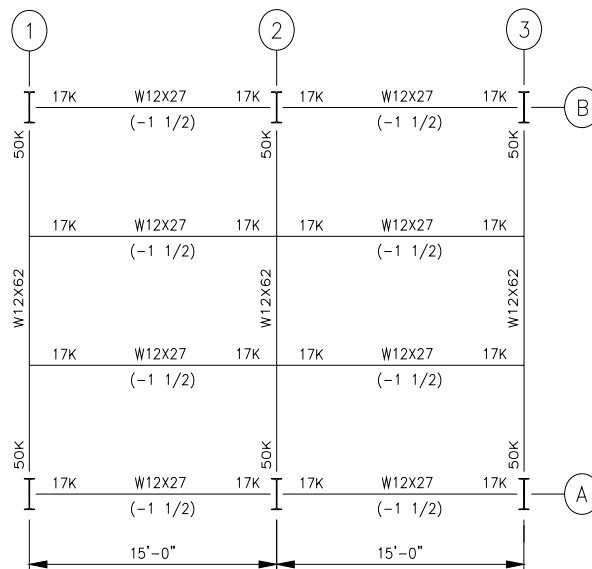


Figure 303-1

3.0 STRUCTURAL STEEL SHAPES

Label structural steel construction, per AISC M013, "Detailing for Steel Construction."

4.0 REINFORCED CONCRETE

Symbols commonly used on reinforced concrete drawings are:

- # To indicate size of deformed bar (superscript)
- Ø Plain rounds, e.g., spirals (superscript)
- @ Spacing center to center
- ↗ Direction in which bars extend
- ↔ Limits of area covered by bars

5.0 STRUCTURAL DRAWINGS

5.1 Dimensioning

On plan views, dimensions are to be tied into points that can readily be transferred to concrete, steel, and other drawings including plot plans. Clearly indicate match lines and centerlines of columns and equipment. When possible, keep dimensions outside the equipment and details. Dimension drawings in feet and inches.

5.2 Elevations

- A. Indicate elevations in decimals of a foot, e.g., EL 96.25. Indicate elevations on Superstructure Concrete and Steel Drawings in feet and inches, e.g., EL 115' - 6-1/2"
- B. Indicate floor and platform elevations to top of steel. Reference floor plate, top of grating or top of slab as + or - elevation to top of steel.
- C. Generally, the high point of the ground floor slab is to be the main vertical reference line.

5.3 Coordinates

On the Floor Plan and Foundation Drawing, locate structures by 2 sets of coordinates. The location of the coordinates shall be the intersection of the column lines and/or at corners of the structure, where practical.

5.4 Loads and Reactions

- A. Indicate the design loads for principal equipment supported on the drawings in their respective locations or in table format.
- B. Note Foundation Drawings with "Max Foundation Bearing Capacity = _____ lbs/sq. ft." Piling Drawings shall be noted with "Max Pile End Bearing Pressure = _____ lbs/sq.ft."
- C. Show floor and roof live loadings as well as wind and seismic design basis for future reference and for floor loading postings.

6.0 REINFORCED CONCRETE DRAWINGS**6.1 General**

In general, the drafting practices shown in the ACI 315, "Details and Detailing of Concrete Reinforcement," published by the American Concrete Institute are acceptable.

6.2 Reinforcing

- A. Space reinforcing bars to the nearest inch, preferably, but in no case shall they be spaced closer than the nearest quarter-inch. *Call-out of bars should be in one view where practical.*
- B. Note bar spacing in inches, and inch marks are not to be used, e.g., #6 @ 18.
- C. Note bending details on the "Bending Schedule for Reinforcing Steel" where job requirements call for detailing the reinforcing. Show and identify bars cut in a section.

7.0 STRUCTURAL STEEL DRAWINGS**7.1 General**

- A. The drawings prepared by the designer shall convey the information necessary for the preparation of erection and shop drawings by the steel fabricator.

- B. Indicate the type of construction, types of beams and columns, and all necessary data on loads, shears, moments, and axial forces to be resisted by all members and their connections on drawings.

7.2 Connection Guidance

- A. *Projects should be shop welded and field bolted where possible.*
- B. *Holes for field connections should be 1/16" larger in diameter than bolt. Holes in structural steel to match equipment hole locations should be made 3/16" larger in diameter than connecting bolts. Holes for anchor bolts in column base plates should be 5/16" larger in diameter than the bolt for 3/4" and 7/8" bolts and 1/2" larger for bolts 1" and over.*

7.3 Welding

- A. Make welding details and notes clear and complete. Provide the size, type, length, and spacing. Draw standard symbols and notations in accordance with the American Welding Society's standards AWS A3.0, Standard Welding Terms and Definitions, and AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination. Several basic welding symbols are contained in Appendix K.

304 ARCHITECTURAL DRAWINGS

1.0 DRAWING DESIGN PREPARATION

- A. All building "plan" drawings at a minimum of 1/8" = 1' - 0" scale and preferably at 1/4" = 1' - 0" scale oriented as previously noted in this manual with a north arrow shown.
- B. All drawing dimensions are to be noted in feet and inches. Tick mark dimension line terminators are for Architectural drawings.
- C. All building elevations are to be drawn in the same scale as the building plan drawings.
- D. Main floor as 100' - 0" elevation on plan.
- E. All plans shall be in accordance with all approved applicable codes, IBC, ANSI, NFPA, and Factory Mutual.
- F. Where plans involve the addition to, or modification of, an existing structure, the existing structure plans shall be "As-Built" with corresponding building information included.

2.0 LIFE SAFETY PLANS

Including but not limited to the following:

- A. Show exits clearly.
- B. Travel paths from furthest distance to comply with codes.
- C. Pull stations.

- D. Fire extinguishers and cabinets.
- E. Emergency phones.
- F. Smoke detectors.
- G. Audio/Visual (A/V) devices.
- H. Handicap facilities.

3.0 DEMOLITION PLANS

Including but not limited to the following:

- A. Limits of demolition.
- B. Show particulate, noise, and visual barriers as well as traffic control barriers.
- C. Clearly note all equipment and material being removed or abandoned in place.
- D. Show evacuation paths from demolition area.
- E. Dimension as required.

4.0 FOUNDATION PLANS

Include the following:

- A. The foundation/building perimeter profile.
- B. Column lines.
- C. Location and profile of all slab/finish floor elevation changes.
- D. Hidden line indicating inside and outside of footing (as applicable).
- E. Hidden line indicating the thickness of monolithic slab turndowns (as applicable).
- F. Location of all piping sleeves.
- G. Building section cut symbols.
- H. Detail or detail section symbols.
- I. Plumbing fixturing and dimensions to centerline.
- J. Locations of all inserts duct trays, recessed electrical receptacles or other specialty items to be inserted into floor concrete.
- K. Dimensions.

- L. Exterior foundation perimeter.
- M. Locations of all offsets.
- N. Locations of all slab/floor depressions.
- O. Expansion joints.

5.0 FLOOR PLANS

Include the following:

- A. Perimeter walls drawn to scale.
- B. Column lines and exterior building columns.
- C. Interior walls drawn to scale.
- D. Plumbing fixturing and centerlines.
- E. Fixed in place partition walls (i.e., restroom partitions).
- F. Locations of windows (width) drawn to scale.
- G. Locations of doors with handing, size (width) and type of movement drawn to scale.
- H. Building section cut symbols.
- I. Detail section cut symbols.
- J. Enlarged plan or elevation identification symbol.
- K. Wall, interior elevation, detail symbols.
- L. Room numbers, symbols, and names (in renaming, check with an ADC for impact).
- M. Cabinetry locations, length and width drawn to scale.
- N. Mechanical, electrical, plumbing and fire protection equipment locations and rooms shown.
- O. Detail, elevation and section symbols shown drawn as per the requirements of this manual.
- P. Areas of enlarged plan shall be identified and referenced.
- Q. Finished floor elevation.
- R. Finished ceiling elevations.
- S. Overhead soffits and suspended equipment.
- T. Dimensions.

- U. Overall building with building additions to include existing building.
- V. Building offsets.
- W. Interior fixtures not dimensioned elsewhere.
- X. Sleeves in cast-in-place concrete walls.
- Y. Door number symbols.
- Z. Window type symbols.
- AA. Wall type symbols.
- BB. Room number symbols.
- CC. Floor drains.
- DD. Fire extinguisher cabinets.
- EE. Housekeeping pads.
- FF. Equipment (stoves, sinks, tables, etc.)
- GG. Ramps with arrows to show direction of slope.
- HH. Raised or recessed floor areas.
- II. Toilet partitions.
- JJ. Fire walls and rating (see Fire Protection section 307 and Symbols (Appendix D-1)).

6.0 REFLECTED CEILING PLANS

Including but not limited to the following:

- A. Show all ceiling finishes.
- B. All exposed structural materials.
- C. Layout of light fixtures.
- D. Direction and pattern of suspended ceiling.
- E. Dimensions as required.
- F. Soffits and chases.
- G. Skylights.
- H. Section and detail cuts.

7.0 FLOOR FINISH PLANS

Including but not limited to the following:

- A. Show patterns of floor finishes.
- B. Dimensions as required.
- C. Ramps, stairs, raised floor, and recessed floor areas.
- D. Housekeeping pads.
- E. Walls, columns, and toilet partitions.
- F. Section and detail cuts.
- G. Room names and numbers.
- H. Notes as required.

8.0 BUILDING ELEVATIONS

Including but not limited to the following:

- A. Approximate final grade line.
- B. Foundation extents identified by hidden line below grade line.
- C. All attributes of building elevations drawn to scale with window and doors having swings identified. Door and window symbols.
- D. Building section cut symbols.
- E. Detail section cut symbols.
- F. Enlarged plan or elevation area symbols.
- G. Each floor elevation and roof bearing elevation shall be identified as well as any changes within a floor line with a 0.050 broken line.
- H. All associated architectural features shall be shown that are relevant to the structure, i.e., finish changes, architectural finish features like inset stucco bands or tile, parapet coping exterior stairs (below grade shown as hidden lines) or free standing entry canopies.
- I. Expansion joints both building and finish. Stucco expansion joints shall be in conformance with the stucco manufacturer requirements.
- J. Building elevation dimensions.
- K. Floor to floor elevations.

- L. Floor to finish ceiling.
- M. Floor to roof bearing-primary or lowest point.
- N. Overall finished first floor to top of roof or roof parapet or mechanical parapet.
- O. Grade to first floor.
- P. First floor to bottom of lower level (as applicable).
- Q. Grade to bottom of footing or turndown.
- R. Independent features-length and width-marked for general notes by numerical symbol.
- S. Overall length.
- T. Any special features, i.e., overhangs and insets.
- U. Notations.
- V. Materials and types.
- W. Special identifications.
- X. Height elevations of window sills.
- Y. Horizontal dimensions as required.

9.0 BUILDING SECTIONS

Include the following:

- A. Drawn to scale minimum of $1/4" = 1' 0"$ preferably $3/8" = 1' 0"$
- B. All sectioned architectural / structural building systems and large components shown.
- C. All background architectural elevation features shown (interior elements).
- D. Primary systems materials section symbols shown.
- E. Vertical dimensions.
- F. Foundation to floor dimensions.
- G. Floor to floor dimensions.
- H. Floor system thickness.
- I. Primary bearing heights.
- J. Elements not vertically dimensioned elsewhere.

- K. Notations & Symbols.
- L. System or component call-outs.
- M. Circled and referenced to enlarged detail as required.

10.0 ENLARGED DETAILS AND PLANS

Include the following:

- A. More detailed information that cannot be accommodated on a smaller scaled drawing.
- B. Materials or components sectioned to show materials symbolically.
- C. Components shown sized and located to scale.
- D. Background components or features.
- E. All materials and components are to be noted and, where applicable, notations shall include height above grade as in plan view.

11.0 ROOF PLANS (CONSTRUCTION)

Including but not limited to the following:

- A. Show access areas.
- B. Overall dimensions.
- C. Roof type (construction type).
- D. Show slope direction.
- E. Pitch.
- F. Roof drains.
- G. Overhangs with dimensions.
- H. Penetrations and type (plumbing, HVAC, etc.)
- I. Penthouses.
- J. Parapet walls and heights.
- K. Fall protection anchor points.
- L. Roofing protected pathways for maintenance access to equipment.
- M. Skylights or roof openings.

- N. Solar energy equipment.
- O. Crickets.
- P. Scuppers.
- Q. Canales.
- R. Downspout locations.

12.0 FLOOR PLANS OF RECORD (FPR)

12.1 General Guidance

- A. *Floor Plans of Record are used as a baseline priority drawing for Facility Management, Space Planning, Space Management, Emergency Response, Emergency Evacuation Plans, Interior Design, As-Built Record Floor Plans, and Information drawings for outside Architects/Engineers for the development of construction drawings to existing facilities, geo-spatial information for Geographic Information Systems, and Title II design. (See §101.D, "General Definitions")*

12.2 Usage

- A. FPRs are not intended for use as construction drawings.
- B. FPRs are used as a baseline priority drawing for developing the following:
 - Facility Management.
 - Space planning.
 - Space management.
 - Emergency Response.
 - Emergency Evacuation Plans.
 - Interior design including systems furniture.
 - As-Built Record Floor Plans.
 - Information drawings for outside Architects/Engineers for the development of construction drawings to existing facilities.
 - Geo-spatial information for Geographic Information Systems.

12.3 Classification of Drawings

- A. Classification:
 - 1. All drawings will be submitted to an ENG Authorized Derivative Classifier (ADC) for classification prior to official release.

12.4 Priority Drawings

- A. All drawings shall be considered Priority Drawings and noted as such on the standard LANL FPR title block.

12.5 Verification of Accuracy

- A. New and existing facilities:
 - 1. All FPRs and RPRs may be reviewed and verified for accuracy through the ENG-Design Review process (contact [ENG-Design Engineering & Construction Services Group](#)).
 - 2. After completion, the electronic CAD file will be submitted to ENG-ITS DCRM Team for recordkeeping. If revisions are necessary, the controlled electronic CAD file will be returned to contractor for modifications.

12.6 Types of FPRs

- A. New Facility:
 - 1. The FPR for a new facility shall be based on the Construction documents developed by the contractor of the new facility.
 - 2. If no As-Built drawing is available, the new facility shall be field validated to an existing condition.
- B. New Addition (or modification) to existing facility:
 - 1. The FPR for the addition or remodel of an existing facility shall be based on the construction documents developed by the contractor of the work.
 - 2. After the construction document is available, the new addition or remodel shall be field validated to its existing condition by ENG-DECS using the ENG space validation process.
 - 3. Generate the FPR in accordance with this manual. This is to include modifications to buildings including room numbering, structure, room and wall configuration, and door and window removal/relocation.
- C. Existing facility with no FPR:
 - 1. Field validate the existing conditions of the facility.
 - 2. Generate drawings in accordance with this manual.
- D. Existing facility with current FPR:
 - 1. Revise the existing FPR in accordance with this manual.

12.7 Format

- A. Drafting:
 - 1. The standard LANL FPR title block sheet shall be inserted in to paper space as an external reference. Plans shall be oriented on the sheet with the building lines parallel to the sheet borders.

2. All entities of an FPR shall be drawn at full scale in model space.
3. Plans will be drawn at the standard scales of $1/16'' = 1''-0''$, $1/8'' = 1''-0''$, or $1/4'' = 1''-0''$. A plan may be drawn to a scale of $1/2' = 1'-0''$ and labeled as an enlarged floor plan for small buildings where the standard scale would not show details properly (e.g., guard stations). The appropriate plan title and scale shall be inserted in paper space. The LANL ESM, Architectural Chapter 4, provides an example drawing (in development) ST4010A5, "Record Floor Plan".
4. If a floor plan is too large to be plotted on one sheet using one of the standard scales, the plan must be broken with the use of a "Matchline" in paper space. This process must be completed in paper space so the original building plan does not get broken or segmented. The building plan will not be broken at any time. The floor plan may be extended to a second or third sheet (tabs) if necessary in paper space. Matchline text to be $3/16''$ in paper space.

B. Dimensioning

1. There shall be only one dimension style. That style should be named LANL.
2. All dimensioning should be done in model space.
3. The settings are as follows:

Action	Setting
First and second arrowheads	Architectural ticks
Leader	Closed and filled
Arrow size	0.125 inches
Dimension text style	Dimension
Dimension text height	1/8 inch
Dimension text color	By layer
Dimension/extension line color	By layer
Primary units	Architectural
Precision	1/16 inch
Angular dimension units	Decimal degrees
Overall scale to be set accordingly to drawing scale used. (e.g., $1/8''$ scale uses overall scale of 96, $1/16''$ uses 192, etc.)	

C. Sheet Numbering:

1. If a basement level exists, the sheet number shall be A-1000. If multiple basement levels exist, they shall be numbered consecutively by use of the Drawing number (e.g., FPR 000_0000_B1, B2, etc.)
2. The first floor plan of the FPR shall be numbered A-1001. The second floor plan of the FPR shall be numbered A-1002, and so on.

3. If it is necessary to break up the building into 2 or more sections with matchlines, the drawing numbering and tab numbering will be assigned as follows:

- B1.1 – Basement level one (first section)
- B1.2 – Basement level one (second section)
- B2.1 – Sub Basement (first section)
- B2.2 – Sub Basement (second section)
- 01.1 – First floor (first section)
- 01.2 – First floor (second section)
- 02.1 – Second floor (first section)
- 02.2 – Second floor (second section)

D. Drawing Electronic File Convention:

1. All FPR drawing files shall be named as follows:

[Floor Plan of Record][Technical Area]_[Building Number]_[Floor]_[Revision Number]

Example: FPR03_410_A-0.1.1_R0

2. All RPR drawing files shall be named as follows:

[Roof Plan of Record][Technical Area]_[Building Number]_[Floor]_[Revision Number]

Example: RPR03_410_A-0.1.1_R0

E. Grid References

1. Grids shall match the original construction documents developed by the contractor of the facility.
2. Column Line designations shall be shown on all sides of drawing as follows:
 - Horizontally, by letter, starting with “A.” (From left to right).
 - Vertically, by number, starting with “1.” (From top to bottom).
 - Letters ‘I’ and ‘O’ shall not be used.
3. The column grid lines shall extend through the entire drawing to the corresponding bubble.
4. FPR symbols and text shall be in accordance with the following standards:
 - Grid bubble size of 1/2” diameter, 0.40 mm line width
 - The grid line shall be a linetype of “CENTER”, having line width of 0.18 mm.
 - The grid line shall be color 13 and screened at 50%.
 - The grid designator text shall be 1/4 inch high.
 - The grid bubble must be an attributed block.

F. Font Styles and Text Size Requirements

1. Notes and all other text shall use the style named “LANL” using a Romans font. (Unless

otherwise specified in this manual)

2. For scales of 1/8" = 1'-0" and above, all text shall be 1/8" high (including dimensions).
3. For scales of 1/16" = 1'-0", all text shall be 3/16" (including dimensions).
4. Text used for dimensioning shall be in the "Dimension" text style, and shall be the appropriate text height.
5. All text shall be oriented so that it reads horizontally from left to right and/or vertically from bottom to top.
6. Only the following text styles shall be used in any FPR drawing (All other styles must be purged from the drawing):
 - LANL
 - DIMENSION
 - ROMAND
 - ROMANS
 - STANDARD
7. Font width factor shall be 1.0 for all text

G. Lineweights

1. All layers will be given one of the following line weights (See attached layer table for assignments):
 - 0.18 mm
 - 0.25 mm
 - 0.40 mm
 - 0.80 mm (matchline only)
2. All FPRs shall have dimensions for the following:
 - Overall building length/width
 - Major building offsets
 - Grid spacing

12.8 Guidelines for Polylines

- A. The "GROS" layer will show the total constructed area of a building. Polylines are to be drawn in accordance with the standard method for measuring floor area in office buildings as outlined in ANSI/BOMA Z65.1-1996.
- B. The "RM" layer will show usable area and all common areas. Polylines are constructed per ANSI/BOMA Z65.1-1996, and shall outline the following areas:
 - All building usable and common areas
 - Vertical penetrations
 - Utility space

- Office areas

12.9 Required Plan Elements

1. Exterior and interior wall construction type, thickness, and room number.
2. Retaining walls and thickness attached to building.
3. Columns and column center lines (Grid lines and numbers).
4. Permanent walls (rooms, hallways, corridors and vestibules) with room numbers.
5. Doors and door swing.
6. Windows – operable configuration addressed per keyed notes.
7. Wall openings that allow passage from one room to another and start at the floor line.
8. Stairways and attached handrails (include stair room number) (show direction of travel – up or down).
9. Utility chases.
10. Exterior wall louvers.
11. Pads at exterior door (concrete and wood).
12. Interior and exterior ramps. Show direction of slope, handrails, and curbs as required by code.
13. Attached docks and canopies.
14. Ladders – both interior and exterior.
15. Elevators and elevator numbers.
16. Built-in millwork and attached equipment.
17. Floor pits, trenches, and numbers.
18. Toilet room partitions and fixtures (plumbing etc.).
19. Overall building dimensions, wall thickness, and outside landing/dock dimensions.
20. Mezzanines and room numbers.
21. Fire wall location and identified with symbols per Appendix D-1 and D-2 (Fire Protection symbols).
22. Raised or recessed floor areas.
23. Columns and column center lines (Grid lines and numbers).
24. Systems furniture cubicles.

12.10 Use the following layering scheme in FPRs:

TABLE 304-1, LAYERING TABLE FOR FLOOR PLANS OF RECORD				
LAYER NAME	LAYER DESCRIPTION	LINE STYLE	COLOR / #	LINE WEIGHT
0	AutoCAD program layer used to import drawings and assign new FPR layers	Cont.	7	0.40 mm
A-COLS	Building columns	Cont.	4	0.40 mm

TABLE 304-1, LAYERING TABLE FOR FLOOR PLANS OF RECORD

LAYER NAME	LAYER DESCRIPTION	LINE STYLE	COLOR / #	LINE WEIGHT
A-DIM	All building dimensions	Cont.	7	0.18 mm
A-DOOR	All doors and door swings	Cont.	1	0.25 mm
A-EXCONC.	Loading docks, door landings and edges of slabs.	Cont.	8	0.25 mm
A-GLAZ	Windows	Cont.	1	0.18 mm
A-GRAPHIC SCALE	Graphic scale and scale text, plan title, and North arrow	Cont.	3	0.25 mm
A-GRID	Grid line	Center	13	0.18 mm
A-GRID-BUBBLE	Grid bubble with text	Cont.	8	0.40 mm
A-LEVL	Level changes, ladders, ramps, pits, and depressions	Cont.	8	0.25 mm
A-MILLWORK	Built-in cabinets and counters	Cont.	11	0.18 mm
A-NOTES	All plan notes.	Cont.	7	0.18 mm
A-PIT	Pits in interior floors	Cont.	8	0.25 mm
A-PLMB	Toilet partitions and plumbing fixtures	Cont.	5	0.25 mm
A-STAIR	Stairs, railings	Cont.	9	0.25 mm
A-TABINFO	Title block notes & information	Cont.	7	0.18 mm
A-TX-RM NBR	Room name, number, and box	Cont.	1	0.25 mm
A-TX-SQ.FT.	Square footage text for room/area	Cont.	8	0.25 mm
A-WALL – EXTERIOR	Exterior building walls and attached retaining walls.	Cont.	4	0.40 mm
A-WALL – INTERIOR	Interior walls, partitions and fences	Cont.	3	0.40 mm
A-WALL-FIRE	Firewalls	Cont.	7	0.40 mm
A-WALL-FIREHATCH	Firewall hatching	Cont.	7	0.18 mm
DEFPOINTS	AutoCAD program use	Cont.	7	0.40 mm
GROS	P-line for external & internal gross areas			
MATCHLINE	Matchline	Phantom	5	0.80 mm
MATCHLINE-TEXT	Matchline text	Cont.	5	0.18 mm
RM	P-line for room areas	Cont.	5	0.18 mm
VIEWPORT	Drawing viewport	Cont.	41	0.18 mm
X-24x36 A-TBLK	X-REF Title Block layer	Cont.	3	0.25 mm
X-24X36 A-TBLK-PRIORITY	X-REF Title Block layer	Cont.	7	0.18 mm

13.0 ROOF PLAN OF RECORD (RPRs)

13.1 General Guidance

- A. *Roof Plans are useful for security, lightning protection plans, and various other operations and maintenance needs.*
- B. *Produce RPRs in a manner similar to FPRs above.*

13.2 Sheet Numbering

- A. The RPR shall be the last sheet in the series of sheets. (If a building has three floors the last sheet will be A-1004).
- B. If it is necessary to break up the building into 2 or more section with matchlines, the sheet numbering will be assigned as follows:
 - R1.1 – Roof (first section)
 - R1.2 – Roof (second section)

13.3 Required Plan Elements

- A. The following shall be reflected in roof plans:
 - 1. Dimensions for major offsets and overall building length/width
 - 1. Roof type (construction type)
 - 2. Slope and Pitch
 - 3. Drain locations.
 - 4. Access locations and types (roof hatch, ladder)
 - 5. Overhang with dimension
 - 6. Penetrations
 - 7. Penthouses
 - 8. Parapet walls
 - 9. Walkpads
 - 10. Screen walls
 - 11. Roofing protected pathways for maintenance access to equipment, (i.e., extra roofing material, roof pavers, and 2" x 4" walkways).
 - 12. Roof edges

TABLE 304-2, LAYERING TABLE FOR ROOF PLANS OF RECORD

LAYER NAME	LAYER DESCRIPTION	LINE STYLE	COLOR / #	LINE WEIGHT
0	AutoCAD program layer used to import drawings and assign new FPR layers	Cont.	7	0.40 mm
A-GRAPHIC SCALE	Graphic scale and scale text, plan title, and North arrow	Cont.	3	0.25 mm
A-GRID	Grid line	Center	13	0.18 mm
A-GRID-BUBBLE	Grid bubble with text	Cont.	8	0.40 mm
A-ROOF-BLDG-BELOW	Line of exterior walls	Dashed2	11	0.18 mm
A-ROOF-ACCESS	Roof ladders and hatches	Cont.	?	0.25 mm
A-ROOF-DIM	All roof dimensions	Cont.	7	0.18 mm
A-ROOF-NOTE	All roof notes, text, and leaders	Cont.	7	0.18 mm
A-ROOF PENETRATION	Penetration & type, exhaust hoods, vents, etc.	Cont.	2	0.18 mm
A-ROOF-SCREENWALL	Protective screen for mechanical, equipment, and fences	Cont.	1	0.18 mm
A-ROOF-WALKPADS	Roof walkpads	Cont.	3	0.18 mm
A-TABINFO	Title block notes & information	Cont.	7	0.18 mm
A-TX-RM NBR	Room name, number, and box	Cont.	1	0.25 mm
A-TX-SQ.FT.	Square footage text for room/area	Cont.	8	0.25 mm
DEFPOINTS	AutoCAD program use	Cont.	7	0.18 mm
MATCHLINE	Matchline	Phantom	5	0.80 mm
MATCHLINE-TEXT	Matchline text	Cont.	5	0.18 mm
VIEWPORT	Drawing viewport	Cont.	41	0.18 mm
X-24x36 A-TBLK	X-REF Title Block layer	Cont.	3	0.25 mm
X-24X36 A-TBLK-PRIORITY	X-REF Title Block layer	Cont.	7	0.18 mm

14.0 MISCELLANY

A. Title Block:

1. Room Information Chart: If the room information chart is too big to fit within the title block it will be placed on its own sheet. It will then become the first sheet in the sheet package.

B. Key Plan:

1. If the building must be broken using Matchlines, a key plan is required that reflects which portion of the building is shown on any given sheet.
 - Key plans will be located at the upper right corner of the title block, and will utilize a 3 inch by 5 inch area.

- A corresponding Title Bar will be associated with each key plan. It will be entitled “Key Plan”, contain a North arrow, and will specify that the key plan doesn’t conform to a scale by notating “No Scale”.
- Key Plans and FPR drawings shall be oriented identically.

C. Title Block Usage:

1. LANL FPR title blocks should be used for internal use only. If the drawing file should be sent to external recipients, the LANL FPR title block should be removed from the drawing file.

14.1 Architectural Stamp

A. Layout Space Requirements:

1. Viewports shall be created to allow for a 2 inch by 2 inch stamp in the lower right-hand corner of the drawing area. These are issued by the State to Architects and Engineers to certify their approval of drawings.

15.0 EVACUATION ROUTE DIAGRAM (ERD) ¹

- A. Use the most current floor plan of record (FPR) to generate an evacuation route diagram.
- B. Verify accuracy of FPR prior to generating ERD. Correct deficiencies in FPR and notify FM-Facility Planning (FP), ENG-DECS, ENG-ITS DCRM Team, and the Facility Manager.
- C. Evacuation route diagrams shall contain the following element locations:
- Fire extinguishers
 - Fire alarms
 - Emergency lighting
 - Evacuation routes (primary in Red continuous line type with flow arrows, secondary route in Blue, dashed line type, pen).
 - Fire horns
 - Fire alarm pull boxes
 - Muster area locations (Primary and Secondary as required) (Coordinated by Emergency Response Management and Facility Management).
 - Legend of symbols (permitted on actual ERP/EEP sheets).
 - Current “24-Hour Emergency Contacts” sign.
 - Exit signs
 - First aid kits
 - “YOU ARE HERE” notation with a solid red circle 1/4 inch in diameter.

¹ Basis: ASTM E-2238-02.

- Temporary shelters should be marked by dashed double red lines, shaded in gray, and labeled “TEMPORARY SHELTER” in 1/8 inch text height in Romand font.

D. ERDs are:

- Considered “Priority Drawings”
- Not required to be drawn to scale, but to fit on one sheet per floor or evacuation area.
- Drawn on “C” size paper and framed per LANL’s picture framing Just-In-Time (JIT) contractor criteria.
- To be wall mounted at locations or prescribed by the Facility Manager and/or ASTM E-2238.
- Mounted 48 inches to 60 inches above finished floor to the center of the sign.
- To follow LANL Drafting Manual guidelines unless otherwise specified.
- To show north orientation in relationship to wall posting.

16.0 ARCHITECTURAL SYMBOLS

- A. Symbols used in the AIA Architectural Graphic Standard (AGS) are of such a large number it would be impractical for LANL to create an architectural symbol library and place them on-line. Therefore, the LANL Symbol Library located on the World Wide Web does not address architectural symbols.
- B. Use the current edition of the Architectural Graphic Standards for:
1. Materials in Large scale section and Graphic representation.
 2. Materials in Small scale Plan Views and Graphic representation.
 3. Surfaces at Small scale and Graphic representation.
 4. Surfaces at Large scale and Graphic representation.

305 MECHANICAL DRAWINGS

1.0 MECHANICAL DRAWINGS

- A. Mechanical Drawings are to include plans, elevations, sections, details, and equipment schedules/lists to clearly define the mechanical requirements of the project.
- B. For symbols used in Plans, Sections, Elevations, Details, and Isometrics, use the standard mechanical symbols found in this manuals [Appendices](#) (Appendices E1 to E3).
- C. Use double-line piping in highly congested areas as necessary to clarify the construction.
- D. Use double-line ductwork, except where not permitted by Project Engineer. Show diffusers, grilles, and registers with sizes, flow rates and directions of flow noted on the drawings or in a schedule. Indicate all thermostats/sensors, duct mounted controls, control panels, etc., on the ductwork drawings.

- E. Place fire protection piping drawings on separate sheets and do not include with other piping system drawings, except as may be specifically permitted by Project Engineer.
- F. Include control diagrams and sequence of operations in the mechanical drawing set, if requested by the client.
- G. Individual large scale mechanical equipment room plan and sections as well as mechanical details shall fully detail the design.
- H. Draw mechanical equipment to scale with required maintenance and tube removal spaces outlined. Ensure that the equipment can be installed and/or removed without having to dismantle or remove other equipment or permanent construction.
- I. Indicate the outline of electrical equipment, including working space clearance, on the mechanical drawings (equipment room, plans, etc.) to ensure that the mechanical equipment does not interfere with the electrical equipment working space as required by the NEC. Do not locate mechanical equipment/piping (i.e., water piping, ductwork, pumps, etc.) above switchboards, panel boards, and motor control centers. Consult with the electrical section designer for the applicable code clearance requirements.

2.0 PROCESS FLOW DIAGRAMS (PFDs) & PIPING & INSTRUMENT DIAGRAMS (P&IDs)

- A. For engineering requirements pertaining to P&ID diagrams, refer to ESM, Chapter 6, Section D10-30PFD.
- B. Refer to the PFD/P&ID Drafting Symbol Library, Appendix G1-G3 of this manual, for drafting symbols to be used in PFD and P&ID.
- C. On PFDs and P&IDs indicate (at a minimum) the items as defined in the ESM, Chapter 6, Section D10-30PFD. Text to be 1/8" high, color white (7), 0.35 mm (0.015") thick.
- D. *P&IDs may extend beyond the drafting field for clarity purposes only. Refer to DSM Section 202.3.0.g, Drawing Title Blocks.*
- E. Do not cross control runs. Break secondary signals, not the process line.
- F. Make flow arrows 1/4 inch.

G. Process Flow Diagram and P&ID Layering Convention modified for LANL use from UDS:

LAYER NAME	DESCRIPTION	COLOR	LINE WIDTH
MI-PC	Main and/or Primary instrument supply or process	13-14	0.70 mm (0.030")
MI-SE	Secondary Systems = Bypasses	1-4	0.50 mm (0.02")
MI-SY	Symbol inserted from the symbol or created on the sheet, plan breaks, continuation flags	7	0.35 mm (0.015")
MI-TX	Text typed or inserted	7	0.35 mm (0.015")
MI-PS	Pneumatic signals	5-8	0.35 mm (0.015")
MI-ES	Electric, electromagnetic, sonic signals	5-8	0.35 mm (0.015")
MI-HS	Hydraulic signals	5-8	0.35 mm (0.015")
MI-US	Undefined signals	5-8	0.35 mm (0.015")
MI-HT	Heat trace	5-8	0.35 mm (0.015")
MI-SL	Software or data link, internal system links	5-8	0.35 mm (0.015")
MI-EL	Mechanical links	5-8	0.35 mm (0.015")
MI-CT	Capillary tube	5-8	0.35 mm (0.015")
MI-WB	Wall barrier	5-8	0.35 mm (0.015")
MI-EX	Existing equipment, systems, components, lines, text, symbols, etc.	9	0.25 mm (0.010")
MI-BL	Buried lines	9	0.25 mm (0.010")

H. *The system flow should generally be from left to right and from top to bottom.*

I. Draw PFD & P&IDs to a scale of 1:1 but labeled as "scale: none" on the drawing.

J. Draw PFD & P&IDs with a snap of 1/16 inch.

K. *For systems having various parameters of operation it is recommended on PFDs that a "Parameter Chart" be shown. The chart should appear on the bottom of the drawing designated for Keyed Notes and General Notes. Layer Text to be 1/8 inch in height, chart outline and vertical columns to be 0.50 mm, 0.025 mm for horizontal lines. Example of a parameter chart as follows:*

Condition #1 = maximum allowable working condition; Condition #2 = normal operating condition; Condition #3 = minimal allowable working condition.

OPERATING CONDITION		KEY COMPONENTS			
		1	2	3	4
CONDITION #1	FLOW	20,000 CFM			
	PRESS	3.5" H ₂ O			
	TEMP	100°F			
CONDITION #2	FLOW				
	PRESS				
	TEMP				
CONDITION #3	FLOW				
	PRESS				
	TEMP				

Figure 305-1

- L. Use table form, using parameters at identified locations on process lines as “Keyed Notes.”
- M. *PFDs may also warrant a mass flow/balance table.*
- N. For symbols required for a PFD and/or P&ID not found in the General Instrument or Function Symbols legend, refer to ISA 5.1. If a symbol is created for a specific project not found in ISA 5.1, create the symbol, add the symbol to the Symbol Legend, and identify the symbol(s) as “non-standard” (NS).
- O. New layers following AIA layering convention per NCS for system specific layouts (i.e., compressed, radioactive liquid waste, tritium, etc.).

3.0 MECHANICAL EQUIPMENT LIST

Example:

MECHANICAL EQUIPMENT LIST				
ITEM NO.	LOCATION RM.NO.	NO. REQ'D.	DESCRIPTION, MANUFACTURER OR APPROVED EQUAL	FURN. BY
1	RM 100	1	PUMP	CONTR

Figure 305-2

- A. Provide a mechanical equipment list for projects required by client.
- B. Provide an equipment list for each individual discipline set (HVAC, plumbing, fire protection, etc.) and locate the sheet in the discipline drawing set as outlined in Section 211 of this manual.
- C. Indicate mechanical equipment items by an item number in a diamond. The item numbers shall be in sequence for the entire mechanical drawing set.
- D. Note in the “FURN. BY” column, if the equipment is furnished by the contractor (CONTR) or Government Furnished Equipment (GFE).

4.0 MECHANICAL SYMBOLS

- A. Use applicable graphics symbols on drawings and include a mechanical legend on the first sheet of the mechanical drawing set.
- B. *Pipe fitting symbols are depicted without a joint connection symbols. The joint symbol is optional; however, the symbols should be consistent throughout the entire mechanical drawing set. It is also preferred to note the type of joint (welded, soldered, flanged, etc.) in the specification and not by use of a symbol.*
- C. Where weld symbols are shown, make welding details and notes clear and complete. Draw standard symbols and notations in accordance with the American Welding Society's standards AWS A3.0, Standard Welding Terms and Definitions, and AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination. Several basic welding symbols are contained in Appendix K.

306 ELECTRICAL DRAWINGS

1.0 GENERAL

- A. Refer to ESM Chapter 7, Section D5000, for discussion of development and a typical one-line diagram.
- B. Use Example Drawing D5000-1, Legend and General Notes, as the starting point for the electrical drawing set legend.
- C. Do not use General Notes on projects that include construction specifications.

2.0 ONE-LINE DIAGRAMS

- A. Use symbols and blocks in accordance with Appendix F of this manual.
- B. Make text 1/8" high, color white (7), 0.35 mm (0.015 inches) thick. Exceptions:
 - 1. Panel designations (i.e., SWB-A, PP-1, etc.) shall be 3/16 inch, AutoCAD font Romand.
 - 2. Items listed in Section 213.2.G.
- C. *One-line diagrams may extend beyond the drafting field (Reference Section 202.3.G) for clarity purposes only.*
- D. Existing conditions to be 0.25 mm (0.010 inches) line width, new conditions to be 0.70 mm (0.030 inches) line width.
- E. *Avoid crossing circuit runs.*
- F. Use conventional drafting standards if one-line diagram continues to another sheet.
- G. Line type for existing conditions: Phantom for conduit wiring and equipment - dashed for enclosures.

- H. Line type for new conditions: Continuous for conduit, wiring and equipment - dashed for enclosures.
- I. Organize drawing to be read from top to bottom. Text read horizontally or vertically, read from the right side of the sheet.
- J. Data input on separate layers (use AIA CAD layering convention). Refer to Section 212.D, Basic Line Widths, for line weight and type.

EXISTING & NEW

Text

Wiring

Conduit

Enclosures

Equipment

- K. Equipment shall be associated with the room number in which it is located.
- L. Refer to ESM Chapter 7, Example Drawing D5000-2, One-Line Diagram.

3.0 ELECTRICAL EQUIPMENT PLANS

- A. Show working clearances for all electrical distribution equipment.
- B. Show equipment plans on separate drawings as follows:
 - 1. Power Plan
 - Major electrical distribution equipment, motors, and major electrical loads
 - 2. Receptacle Plan
 - Receptacles and circuiting
 - Locations of the branch circuit panels
 - 3. Lighting Plan
 - Lighting fixtures, switches, and circuiting
 - Emergency and exit lighting fixtures and circuiting
 - Location of the branch circuit panels
 - 4. Special Systems Plan
 - Telecommunications outlets
 - Telecommunications rooms
 - Fire Alarm System
 - Security equipment
- C. Use standard symbols and blocks in accordance with Appendix F of this manual.

4.0 WIRING DIAGRAMS

- A. Refer to ESM Chapter 7, Example Drawing D5020-1, Motor Control Wiring Diagrams.
- B. Show the connection of an installation or its component devices, controllers', and equipment.
- C. A wiring diagram may cover internal or external connections, or both, and shall contain such detail as is needed to make or trace connections that are involved. *It usually shows the general physical arrangement of devices and device elements and also accessory items such as terminal blocks, fuses, power supplies, etc.*

5.0 ELECTRICAL SCHEMATICS

- A. Requirements: Use standard symbols and blocks in accordance with Appendix F of this manual.
- B. *Guidance:*
 - 1. *Refer to ESM Chapter 7, Example Drawing D5020-1, Motor Control Wiring Diagrams and D5000-2, One Line Diagrams.*
 - 2. *Schematic diagrams show, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component device or parts.*
 - 3. *Schematics are intended to show major components and the flow of electrical power and control.*
 - 4. *Schematics are not intended to show wire sizes or terminations, etc.*

6.0 ELECTRICAL SCHEDULES

- A. Refer to ESM Chapter 7, Section D5010.2.7, Figure D5010-1 or its successor, for typical schedules.
- B. Use standard symbols and blocks in accordance with this manual.

7.0 LIGHTNING PROTECTION SYSTEM (LPS)

- A. Lightning protection drawings are considered "priority drawings".
- B. Use the lightning protection symbols furnished in this manual.
- C. Use existing roof plans of record (RPR) or generate new drawings to indicate LPS.
- D. *Guidance: Use example drawing D5090-1 (in development) as template for elements to be shown on the drawing.*
- E. Reference other disciplines if coordination is required either in Key Notes or General Notes.
- F. Show LPS for: stacks, VTRs, mechanical equipment, roof drains, ladders, hatches, and access ways, etc.

Basis: NFPA 780.

307 PLUMBING

1.0 GENERAL

- A. Water distribution and waste/vent disposal systems shall be shown on the same plan as they occur servicing the fixtures on the floor represented.
- B. Waste lines shall be drawn – continuous line type, 0.8 mm.
- C. Vent lines shall be drawn – dashed line type, 0.35 mm.
- D. All line types on plumbing systems shall have breaks indicating the type of systems (i.e., - RD -, - S -, - CA -, -- V --, etc.)

2.0 PLUMBING SYSTEMS

- A. Plumbing systems are comprised of:
 - 1. Water: potable, non-potable, grey, soft, distilled, deionized, chilled drinking fountain, make-up.
 - 2. Compressed Air
 - 3. Natural Gas
 - 4. Waste: sanitary, roof drain, overflow roof drain, septic, indirect drains, acid, industrial
 - 5. Fuel oil
 - 6. Petroleum
 - 7. Vacuum
 - 8. Steam and Condensate
 - 9. Vent

Note: Some systems listed above that are connected to plumbing equipment may require interface coordination with other disciplines. These interfaces may need to be reflected in System Design Descriptions (SDD), if applicable.

Basis: American Society of Plumbing Engineers.

3.0 ISOMETRICS AND SCHEMATICS

- A. Isometrics and schematics shall depict the following:
 - 1. pipe size
 - 2. pipe material
 - 3. direction of flow
 - 4. system type (V=vent, S=sanitary waste, etc.)
 - 5. equipment/fixture identifier
 - 6. room numbers where equipment/fixture is located

- 7. location of piping by keyed note
- 8. access panels
- 9. slope with pitch arrow including fall expressed in fraction-of-an-inch per foot length of pipe (on main runs)
- B. Isometrics shall appear in the P-9000 series, schematics/diagrams in the P-6000 series.
- C. Isometrics/diagrams for new systems shall show the entire system layout. Several systems may appear on the same sheet.
- D. Plumbing equipment schedules shall appear in the P-7000 series.
- E. Plumbing fixture/equipment identifier system:

P-1 water closets	P-6 kitchen sinks
P-2 urinals	P-7 service (janitor) sinks
P-3 lavatories	P-8 water heaters
P-4 showers	P-9 hose bibs
P-5 drinking fountains/water coolers	P-10 to P-? user defined
Note: Use suffixes to depict variations to the fixture selection (i.e., P-3A counter top handicap, P-3B wall hung, P-4A handicap, P-7A pedestal type, etc.)	

308 FIRE PROTECTION DRAWINGS

1.0 DRAWING DESIGN PREPARATION

- A. Draw to scale and show north arrow symbol. Show dimensions, including elevations in feet and decimals of a foot.
- B. Include on drawings, plans and site plans existing features such as buildings, roads, walks, parking areas, large trees, underground and overhead utilities, valve boxes, water meters, fire hydrants, pressure reducing valves, backflow preventers, thrust blocks, valve pits, and other features pertinent to the specific project.
- C. The types of plans required for preparing a fire protection drawing set include floor plans, reflected ceiling plans, elevations, sections, isometrics, schematics and schedules. Reflected ceiling plans should show locations of lights, diffusers and other devices installed at the ceiling. Related plans should show ductwork layout. Include within each submittal all symbols, legends, and notes needed to understand everything shown on the drawings. See Section 2.0.

- D. The information to be shown on the working plans for installing fire protection systems is listed in Sections 3.0 through 7.0. Related information that is normally handled in other drawing sets is listed in Section 8.0.
- E. Support the information shown on the drawings with a detailed Bills of Materials listing numbers and types of all devices provided. The Bill of Materials can be incorporated on the drawings or can be separate. It should match the manufacturers' literature submitted for the project.
- F. Fire protection project drawings include those showing building structural features, emergency lighting, fire alarm systems, special extinguishing systems, sprinkler systems, and fire protection water supplies. For some projects, other types of drawings could be included.
- G. Fire protection symbols (Appendix D) per NFPA 170.

2.0 BUILDING ARCHITECTURAL AND STRUCTURAL FEATURES

- A. Show in plans the building architectural and structural features relating to fire and explosion resistance. These features include, but are not limited to:
 - Location of fire barriers (walls/floors/ceilings)
 - Material, thickness, and rating of fire barriers
 - Location and height of parapets
 - Roof construction
 - Rated fire doors/hatches
 - Penetrations of fire barriers and any protection provided for those penetrations
 - Fire- or explosion-resistant construction details including fireproofing on structural members
 - Location, construction, and size of concealed spaces, attics, closets, bathrooms, and other small enclosures
 - Locations and heights of unrated walls and partitions
- B. Some of these features will need to be coordinated with Site, Structural, and Architectural drawings. Some of these features will also need to be shown on the drawings for Sprinklers, Egress Routes, and Special Extinguishing Systems.

3.0 EMERGENCY LIGHTING

- A. Include in plans for emergency lighting all the elements required by NFPA 101. Plans should cover the following:
 - Type of lighting provided
 - Location of lights
 - Conduit routing
 - Dedicated outlets

- Wiring schematic
- Type of back-up power provided

4.0 FIRE ALARM SYSTEMS

- A. The fire alarm system designer should prepare working plans that show the features described in NFPA 72. Drawings for fire alarm systems should include:
1. Locations and types of all fire detectors (heat, smoke, flame, gas detection, etc.).
 2. Locations of manual pull stations.
 3. Location and type of fire alarm panel and auxiliary panels.
 4. Locations of notification appliances.
 5. Candela rating of visible notification appliances.
 6. Locations and types of remote annunciators and graphics interfaces.
 7. Fire alarm zone schedules, designations and descriptions.
 8. Conduit type and routing.
 9. Fire alarm riser diagram.
 10. Point-to-point wiring schematics between the panel and all devices.
 11. Device addresses.
 12. Location of walls, partitions, sound attenuation materials, and other building construction features that affect placement of fire alarm system components.
 13. Sprinkler and special extinguishing system points to be monitored (water flow switches, water pressure switches, special agent discharge, valve tamper, etc.).
 14. Air handling plenums with smoke detection/shutdown.
 15. Components interlocked with the fire alarm system, such as elevators, dampers, fire doors, smoke doors, special extinguishing systems.
 16. Sequence of operation logic diagram or narrative description.
 17. Battery calculations.

5.0 SPECIAL EXTINGUISHING SYSTEMS

- A. Special extinguishing systems include both water- and nonwater-based systems arranged specifically to protect a particular hazard. These systems include:
1. Clean agent
 2. CO₂
 3. Deluge
 4. Dry chemical
 5. Foam
 6. Foam-Water

7. Preaction
- B. The special extinguishing system designer should prepare working plans that show the features described in the appropriate NFPA codes, including NFPA 11, NFPA 11A, NFPA 12, NFPA 15, NFPA 16, NFPA 17, NFPA 17A, NFPA 18, and NFPA 2001. Include in the plans all structural details that could have an effect on nozzle positioning. This would include the geometry of the room and the hazard being protected.
- C. Include complete information on the detection systems, including types of detectors, locations of detectors, and control logic for alarm and agent release. Also include wiring schematics and calculations for battery back-up power. Calculations for the extinguishing agent itself are usually prepared separately from the plans.

6.0 SPRINKLER SYSTEMS

- A. The sprinkler system designer should prepare working plans that show the features listed in NFPA 13, Section 8-1, Working Plans. When inside standpipes and/or hose are included in the project, also include the relevant information from NFPA 14.
- B. Elements to be included in the plans are:
 1. Sprinkler head information: makes, models, manufacturer, date of manufacture, type, temperature rating, K-factor, RTI, pendent/upright/sidewall, etc.
 2. Sprinkler head locations.
 3. Number of each type of sprinkler, number of sprinklers per floor, and total number of sprinklers.
 4. Pipe type, sizes, lengths, and locations.
 5. Dimensions between sprinkler heads, between branch lines, and from end sprinkler heads to the nearest wall(s).
 6. Types, sizes and locations of all fittings.
 7. Locations of low point drains.
 8. Types, sizes, and locations of all valves, including control (shut-off) valves, alarm check valves, dry pipe valves, backflow preventers, etc.
 9. Point of connection to existing sprinkler systems.
 10. Locations of hydrants and fire department connections.
 11. All auxiliary piping and trim, including piping to water motor gongs, and all drains and inspector's test connections.
 12. Capacity in gallons of dry pipe systems.
 13. Pitch of all piping for dry systems.
 14. Hydraulic design, hydraulic reference points, outline of the calculated areas, and hydraulic demands for nameplate data. (Sprinkler hydraulic calculations are usually prepared separately from the plans.)
 15. Locations of water flow alarms and valve tamper devices
 16. Locations of hose connections and standpipes

- 17. Elevations of pipes and sprinklers above finished floor
- 18. Earthquake bracing (Seismic calculations are usually prepared separately from the plans.)
- C. Include in the plans all structural details that could have an effect on sprinkler head positioning. This would include, but not be limited to, beams, drop ceilings, soffits, full- and partial-height partitions, and any other potential obstructions to sprinkler discharge. Show structural details in elevation or isometric view, or on plan views with elevations called out.

7.0 WATER SUPPLIES

- A. Incorporate in plans for fire protection water supplies the information from the appropriate NFPA codes, including NFPA 13, NFPA 14, NFPA 20, NFPA 22, and NFPA 24. Include plans for the following:
 - 1. Underground Mains in streets and at facility
 - 2. Pumps
 - 3. Tanks
 - 4. Hydrants
 - 5. Control and sectional valves

8.0 OTHER SYSTEMS

- A. Life safety analysis, including egress routing and determination of travel distances, will normally be shown in the Architectural drawing set.
- B. Fire and smoke dampers for building HVAC systems, access doors to HVAC dampers, ventilation systems for areas containing vapors, and smoke control systems will normally be shown in the Mechanical drawing set. Fuel-fired equipment will also be in the Mechanical set.
- C. Lightning protection, building and process back-up power systems, and electrical equipment for hazardous areas will normally be shown in the Electrical drawing set.
- D. Process Safety Controls, including P&IDs, will normally be shown in the Instrumentation and Controls drawing set.

9.0 ATTACHMENTS

ATTACHMENT 1: HISTORICALLY USED DRAWING NUMBERS

ATTACHMENT 2: EXISTING FACILITY MODIFICATION PROCESS GUIDANCE

10.0 APPENDICES

APPENDIX A: GENERAL – PLOT LIMITS, TXT CONVERSIONS, LINE TYPES CHART

APPENDIX B: GENERAL SYMBOLS CHART

APPENDIX C: CIVIL SYMBOLS CHART

APPENDIX D 1-3: FIRE PROTECTION SYMBOLS CHART

APPENDIX E 1-3: MECHANICAL SYMBOLS CHART

APPENDIX F 1-3: ELECTRICAL SYMBOLS CHART

APPENDIX G 1-4: P&ID AND PFD SYMBOLS CHART

APPENDIX H: TITLE BLOCKS AND TITLE SHEET INFORMATIONAL CHART

APPENDIX I: ARCHITECTURAL SYMBOLS CHART

APPENDIX J: PLUMBING SYMBOLS CHART

APPENDIX K: WELDING SYMBOLS CHART